DEFINITION OF SEVERE WEATHER METRIC

"COUNTY AREA RATIO"

Ken Waters
National Weather Service
Pacific Region HQ
Honolulu, Hawaii
E-mail: ken.waters@noaa.gov

May 8, 2006

Introduction

A new performance measure is needed to measure improvement in issuing severe weather warnings using polygons rather than counties. For several years the National Weather Service (NWS) has been using polygons to describe the primary threat area for tornado (TOR), severe thunderstorm (SVR), flash flood (FFW), and special marine warnings (SMW). However, for many of the warnings issued the polygon has basically just been the shape of the county, somewhat defeating the purpose of defining a polygon for the warning area. Therefore a new performance measure, **County Area Ratio**, has been created.

Definition

The **County Area Ratio**, or **CAR**, is defined as the ratio of the area of a polygon warning to the area of the warned counties:

$$CAR = 1 - \frac{PA}{\sum CA}$$

Where   PA = Area of the polygon warning in square miles
         CA = Area of the county/counties in square miles

This ratio measures the improvement of reducing the size of warnings by using polygons. The county area consists of the sum of all counties identified by the inclusion of the Universal Geographic Code (UGC) in the text of the warning. It should be noted that it is possible for a polygon warning to cover a small portion of a county but still not be "officially warned" on by virtue of the UGC in the warning. Also of note is that a few warnings were issued where the polygon was much larger than the warned county area. This was due to a variety of reasons including instances where the polygon was extended

well beyond the issuing forecast office's area either into a neighboring office or possibly offshore.
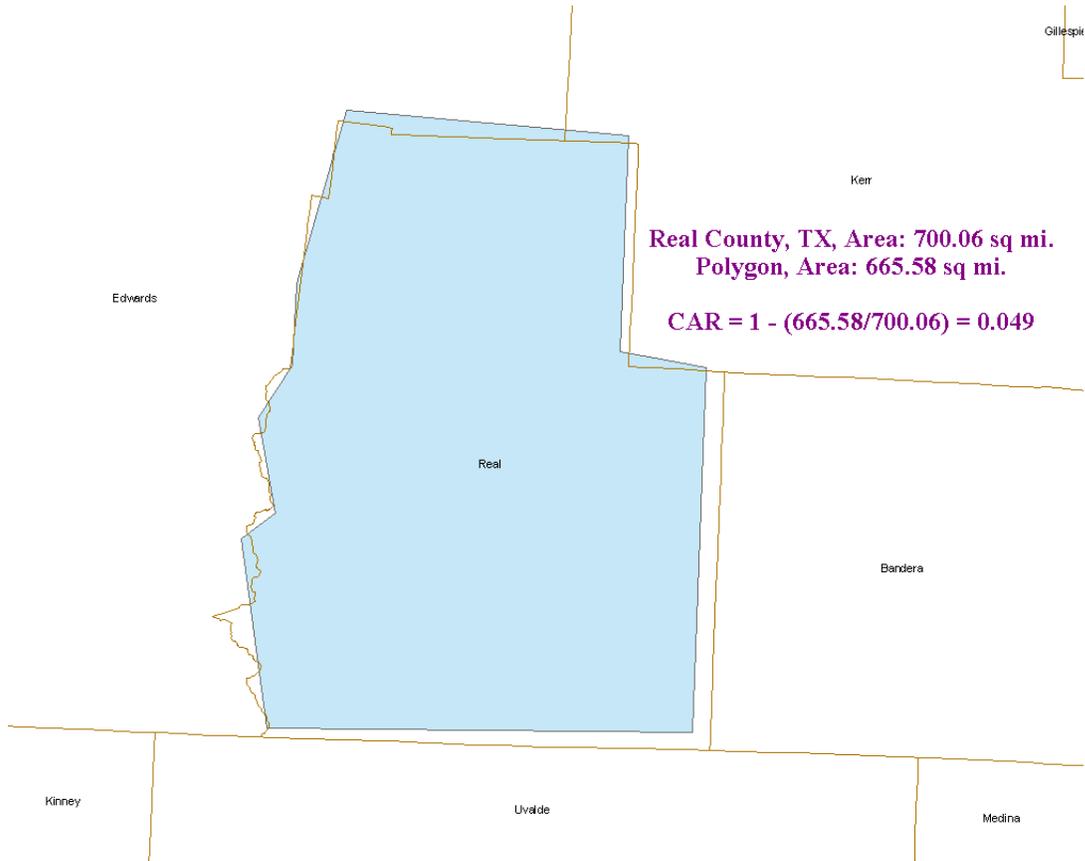
Data and Methodology

Data are the official text warnings issued by the National Weather Service for 2004 and 2005 (through September). The data set included 53,835 warnings for this 21 month period. The polygon information located at the end of the warning bulletins was extracted and converted into Geographic Information System (GIS) shapefile format. GIS software was then used on the full set of warnings to calculate the area in square miles of each warning and exported to a spreadsheet. Using the same GIS software, a field is populated with the sum of the county areas that each warning is issued for. Finally, a CAR is produced for each warning and the sum of both fields is used to calculate a national CAR value.

The use of GIS greatly simplifies this task and allows for a high degree of precision in computing these values. In addition, GIS enables further complex analysis such as verification of warnings against actual occurrences of severe weather.
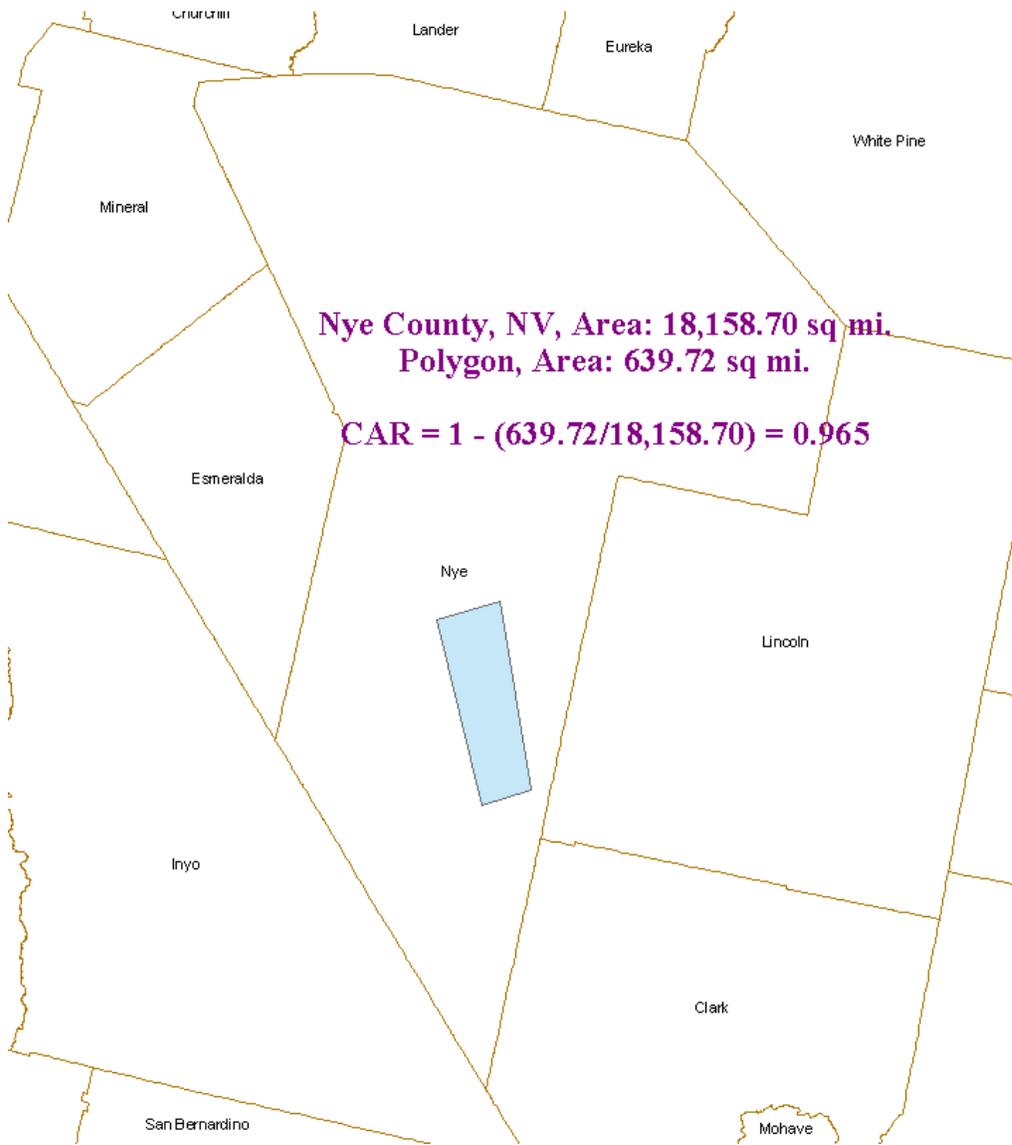
Examples

Following are three different examples showing how the CAR is computed.

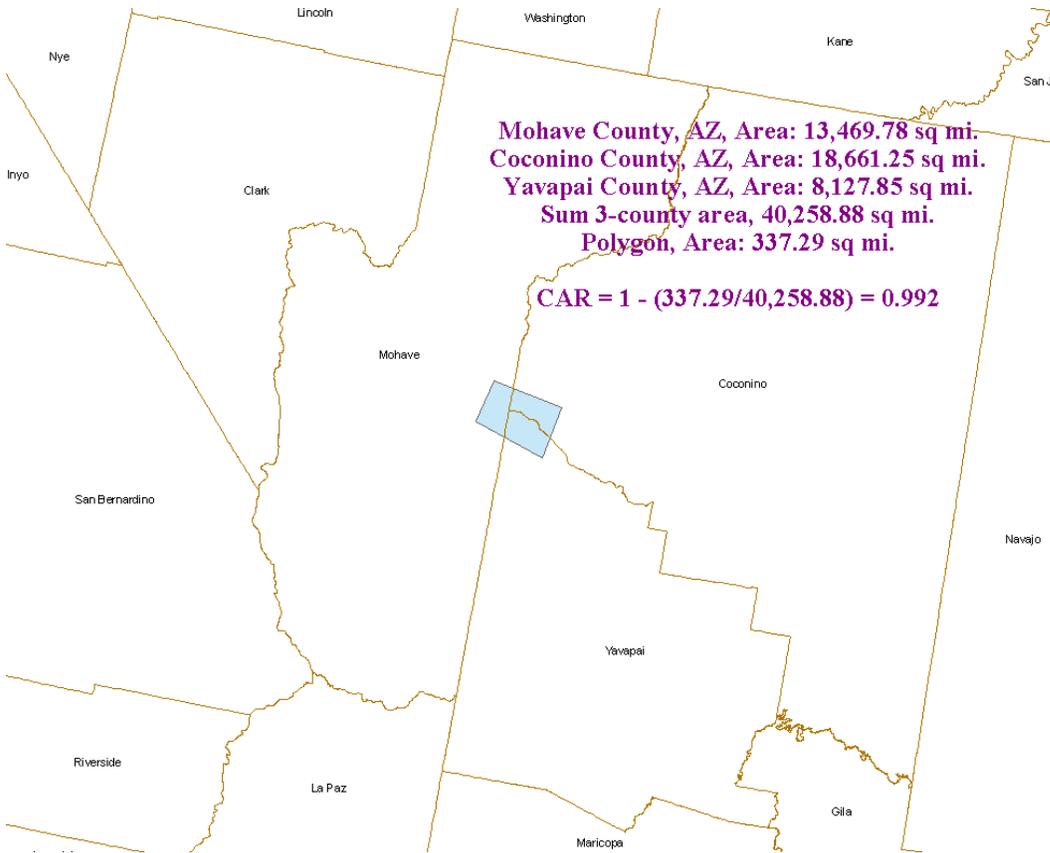Example 1: One-county warning with the polygon largely emulating county boundaries.

Gillespie

Kerr

Real County, TX, Area: 700.06 sq mi.
Polygon, Area: 665.58 sq mi.

CAR = 1 - (665.58/700.06) = 0.049

Edwards

Real

Bandera

Kinney

Uvalde

Medina

Example 2: One-county warning with a polygon as a small subset of the county.

Nye County, NV, Area: 18,158.70 sq mi.
Polygon, Area: 639.72 sq mi.

$$CAR = 1 - (639.72/18{,}158.70) = 0.965$$

Example 3: A three-county warning with a small polygon at the junction of the three counties.

Mohave County, AZ, Area: 13,469.78 sq mi.
Coconino County, AZ, Area: 18,661.25 sq mi.
Yavapai County, AZ, Area: 8,127.85 sq mi.
Sum 3-county area, 40,258.88 sq mi.
Polygon, Area: 337.29 sq mi.

$$CAR = 1 - (337.29/40,258.88) = 0.992$$

Analyses

To date, the CAR has been computed for all TOR, FFW, and SVR warnings for the 2004 and most of the 2005 season. Data has not been calculated for SMWs due to the fact that these warnings are issued over water and therefore a comparison of polygon area to county area would not be useful. Results have shown a typical average CAR of 70%, thus indicating that on average, polygons tend to be issued for only 30% of an average county area. However, as the examples above indicate, there is a substantial variance in these numbers. In general, CARs tend to be larger for the western U.S. due to the large county area size in the west.

	2004	2005 (thru Sept 30)
CAR	63.79%	69.95%

Conclusion

Initial work with the CAR metric has shown it to have significant value in measuring the tendency for an office to issue warnings by polygon rather than by county. Values of the CAR near zero indicate warnings with polygons that emulate county areas. Values of the CAR just under one are at the other end of the spectrum describing situations where a relatively small polygon was defined within a subset of one or more counties. Computing values of CAR provides the needed objective measure of the effectiveness of the NWS' Polygon Warning initiative.